Available online at www.sciencedirect.com
ScienceDirect
Advances in Space Research 43 (2009) 401–412
ADVANCES IN SPACE RESEARCH (a COSPAR publication)
www.elsevier.com/locate/asr

Height and time variability of planetary wave activity

V.V. Guryanov *, A.N. Fahrutdinova

Meteorology Department, Kazan State University, 18 Kremlevskaja Street, Kazan 420008, Russia

Received 26 October 2006; accepted 5 June 2008

Abstract

The height–season and year-to-year regularities of parameters of first and second spatial harmonics determine the structure of the stratosphere and mesosphere circulation and its variability. In the period 1992–2002 at heights 0–55 km, the amplitudes and phases of the first and second spatial harmonics in the field of temperature, geopotential height, zonal and meridional wind were calculated by the method of harmonic decomposition. Dispersion (standard or mean square deviation) of their day-to-day and year-to-year variations was calculated by their wavelength constants. Height and season patterns of variability have been estimated. The difference in height–longitude variability for wave numbers $m = 1$ and 2 has been discovered. At the same time, the intensity of wave disturbances for $m = 1$ is less than for $m = 2$ excluding the polar areas, where a significant variability appears at the heights 0–55 km. There is also a tendency for the intensity of year-to-year variations to decrease in comparison with day-to-day variations. In cold and warm periods the amplitude of perturbation waves with $m = 2$ both for day-to-day and year-to-year variations is greater than for waves with $m = 1$. Transient height areas in the interval of 20–30 km are more distinct for day-to-day variations of polar area.

The mean square deviation (RMS) of the first harmonic of the zonal and meridional winds is less than that of the second harmonic and its year-to-year variability is less than day-to-day one. The amplitude of the first harmonic of zonal and meridional wind is higher than the amplitude of the second harmonic, and the day-to-day variability is greater than the year-to-year variability for the Northern hemisphere. The heterogeneous height and latitude structure is a characteristic of the year-to-year variation of the phase of the second harmonic. It could be caused by a non-steady state of the second harmonic.

Keywords: Reference atmosphere models; Middle atmosphere; Planetary waves

1. Introduction

The global empirical data on fundamental meteorological parameters of the stratosphere (temperature, geopotential height, zonal and meridional wind) acquired to date and represented in the Met Office Stratospheric Assimilated Data Archive permit not only the determination of basic structural characteristics (for instance, those contained in Reference Models CIRA, 1972) (Barnett and Corney, 1985a,b; Labitzke and Barnett, 1985) but also the study of their space–time variability. Mean square deviations of the amplitudes and phases of the indicated meteorological fields have been determined to that effect for zonal wave numbers $m = 1$ and 2 for the Northern and Southern hemispheres, the 1992–2002 period and a pressure range from 1000 to 0.316 hPa (approximately 0–55 km). The final results are presented as height–latitude sections with a sampling period of 1 month.

The multi-year variability of any meteorological value in a particular month should be considered to be the sum of its dispersions reflecting the effect of variations of the whole spectrum of time scales (from 2 days and more) on its total variability. These variations can be produced by both nonperiodic and periodic processes. If the studies are based empirically on daily data (as in the case under review), the nonperiodic variations are mainly represented by variations caused by meteorological changes within each month. It is obvious that variations with periods between

* Corresponding author. Tel.: +7 8432 388 132; fax: +7 8432 387 418.
E-mail address: Vladimir.Guryanov@ksu.ru (V.V. Guryanov).

0273-1177/$34.00
doi:10.1016/j.asr.2008.06.002